ories. The anomaly is now understood: it is impossible to maintain chirality, and the associated current algebra, in the presence of electrodynamics in any theory that includes Fermion fields. Adler does not tell us, since no one knows at the present time, whether or not anomalies are present in nature as well. The anomaly associated with pion decay seems to be experimentally indicated, since that decay is observed. However, other anomalies do not have clear experimental verification.

Much speculative theory has been built on the recent M.I.T.-SLAC investigation of inelastic electron-nucleon scattering in a certain high energy domain. One way of understanding the data is to say that masses become irrelevant and a new symmetry sets in in this high energy region. The symmetry is called scale or dilatation invariance and corresponds to the possibility of rescaling space-time parameters in a theory without affecting physical content. (This is somewhat analogous to the symmetry of translation invariance —the possibility of translating space-time parameters without affecting physical content.) That this symmetry should be useful for particle physics was first advocated by Kastrup and Wess; and now, motivated by the M.I.T.-SLAC data, many people have looked into the subject. One result has been the clarification of the nature of the energy-momentum tensor in local field theory. Also, it was suggested by Mack and later by Gell-Mann that there may be a simple connection between chirality and scale invariance since both symmetries appear to be broken by masses. All this is discussed in Zumino's lecture, where extensive use is made of effective Lagrangians, a technique introduced into physics by Weinberg and Schwinger. More recent investigations, however, have shown that anomalies, which were the exception in current algebra, are the rule here; and it is still uncertain if and how scale symmetry can be usefully employed in particle physics. Wilson has suggested that scale invariance places important constraints on the short distance behavior of products of local field operators, and Zimmermann's lectures report on the verification of Wilson's ideas in perturbation theory.

A more successful speculation is that of duality in hadron physics: it is postulated that the high-energy Regge model should be valid at low energies, while low energy resonance dominance should extend to high energies. Jacob develops these ideas with strong emphasis on phenomenological applications, and Mandelstam lectures on the abstract dual-resonance model which has arisen largely from the work of Fubini and Veneziano. Though beset by several serious shortcomings, this model exhibits in a remarkably elegant and compact fashion many of the constraints that duality, Regge ideas, and other such concepts impose on physical scattering amplitudes. These two lectures are an excellent discussion of an idea that may finally succeed in providing a useful model for hadron dynamics.

These volumes can be recommended as timely introduction to many subjects of current interest in theoretical particle physics.

ROMAN JACKIW
Department of Physics, Massachusetts Institute of Technology, Cambridge

Nonideal Techniques

Probes of Structure and Function of Macromolecules and Membranes. Proceedings of a Johnson Research Foundation colloquium, Philadelphia, April 1969. Academic Press, New York, 1971. Vol. 1, Probes and Membrane Function. BRITTON CHANCE, CHUAN-PU LEE, and J .KENT BLASIE, Eds. xxx, 552 pp., illus. $13.50. Vol. 2, Probes of Enzymes and Hemoproteins. BRITTON CHANCE, TAKASHI YONETANI, and ALBERT S. MILDVAN, Eds. xxviii, 626 pp., illus. $14.

These two volumes contain 120 articles plus discussions resulting from the fifth Johnson Research Foundation Colloquium. The experiments discussed have the goal of determining the detailed structural basis of enzyme activity and membrane function. Obviously this would not be a great problem if we had an ideal microscope, one applicable to hydrated materials, with 0.1 Å spatial resolution and 10 nsec time resolution. But we do not, and against the ideal microscope must be set the numerous and nonideal techniques available to biologists at present and described in these volumes.

The first and most valuable portion of the colloquium is the sections on techniques. For many techniques, the articles emphasize limitations and difficulties in interpretation not often enough made explicit in the general literature. Several articles discuss fluorescence and absorption methods, and single articles are devoted to nuclear magnetic resonance, electron paramagnetic resonance, nuclear magnetic relaxation, and electron-nuclear double resonance, all of which have only recently been applied to biological problems.

The second section of the colloquium is concerned with the application of the fluorescent probe technique to membrane function. Two-thirds of these articles are about mitochondria and a slightly different two-thirds are contributions from the Johnson Foundation itself.

Three further sections are devoted to the variety of approaches being used to determine structure-function relationships in mitochondria, in dehydrogenases, and in hemoproteins. A small section is devoted to improvements in instrument technology.

The volumes are not intended as an introduction for the novice. The first article of the second volume begins with the sentence, "A 5 Å resolution electron density map of dogfish M4LDH, which crystalizes in space group F422 with a = 146.9 Å, c = 155.1 Å and a single peptide chain (MW 35,000) in the asymmetric unit, has been obtained. . . ." The terms "State 3," "State 4," and "State 5" are frequently used to describe mitochondria but no hint is given about their meaning. No serious editing seems to have been done. While the excitement (and acrimony) of the discussion is thus preserved, the less well informed reader is poorly served.

The volumes were produced by offset reproduction of typewritten pages. In spite of the rapid publication method, the delay between symposium and publication was two years and some months. Only a few of the articles are updated with notes added in proof.

Improvements approaching the ideal microscope may be forthcoming. At the colloquium Parsons described attempts to develop electron microscopy for hydrated samples. Since then, more powerful x-ray sources have been introduced which may add time resolution to the spatial resolution of this technique. Better probes and spin labels are being synthesized. Thus there is real hope that the articles in the two volumes represent only the beginning of a molecular understanding of enzyme and membrane function.

LARRY COHEN
Department of Physiology, Yale University School of Medicine, New Haven, Connecticut